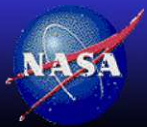


Time and Space Averaging studies using CERES/GERB/ScaRaB

David Doelling, C. Nguyen, L. Lusheng, Norm
Loeb, M. Nordeen, R. Raju, D. Keyes

CERES/GERB/ScaRaB synergy session, September 15, 2010, Paris France

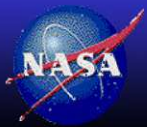


NASA Langley Research Center / Atmospheric Sciences



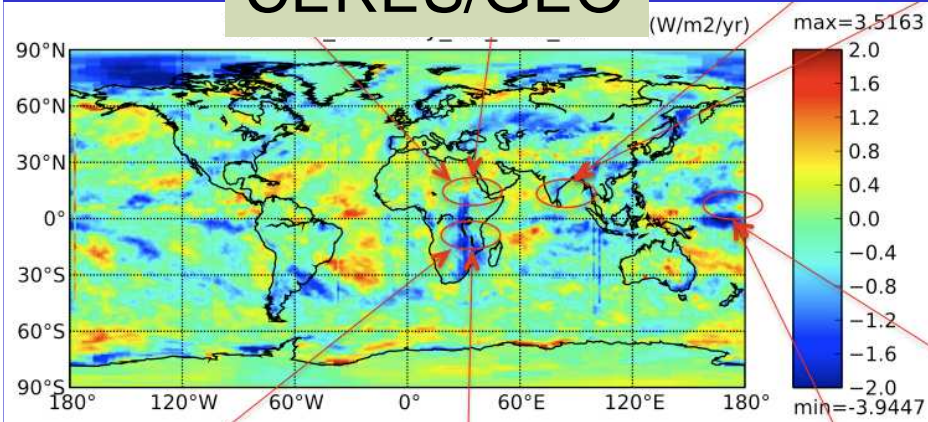
Motivation

- If you only had one ERB satellite what orbit would you choose, SS or precessionary?
- Can there be diurnal cycle changes that go undetected with a sun-synchronous orbit?
 - Can the change be undetected between two measurements per day?
- Climate change to predict greater extreme events
 - Stronger convection over land, ~18 local time
 - Maximum and Minimum temperatures, sunrise and noon
- Synergy needed between SS and precessionary or geostationary orbits needed to unravel many simultaneous trends in climate

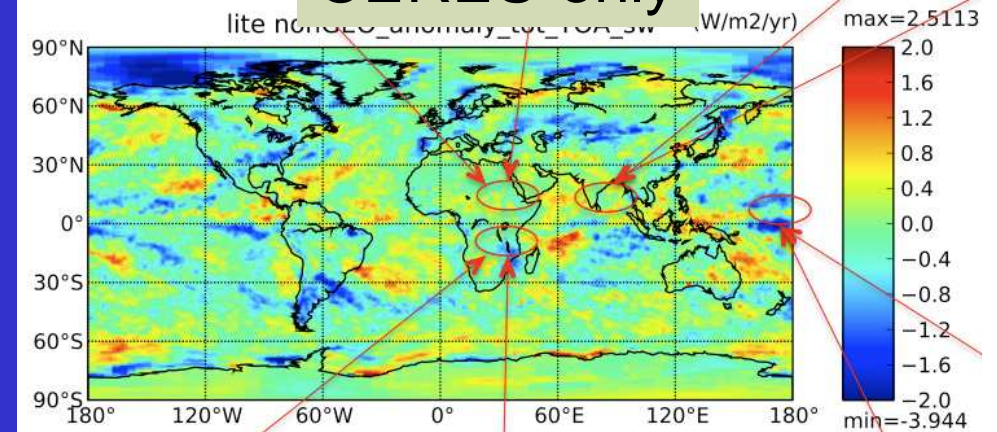


8-year SW trend anomalies

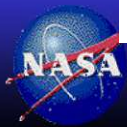
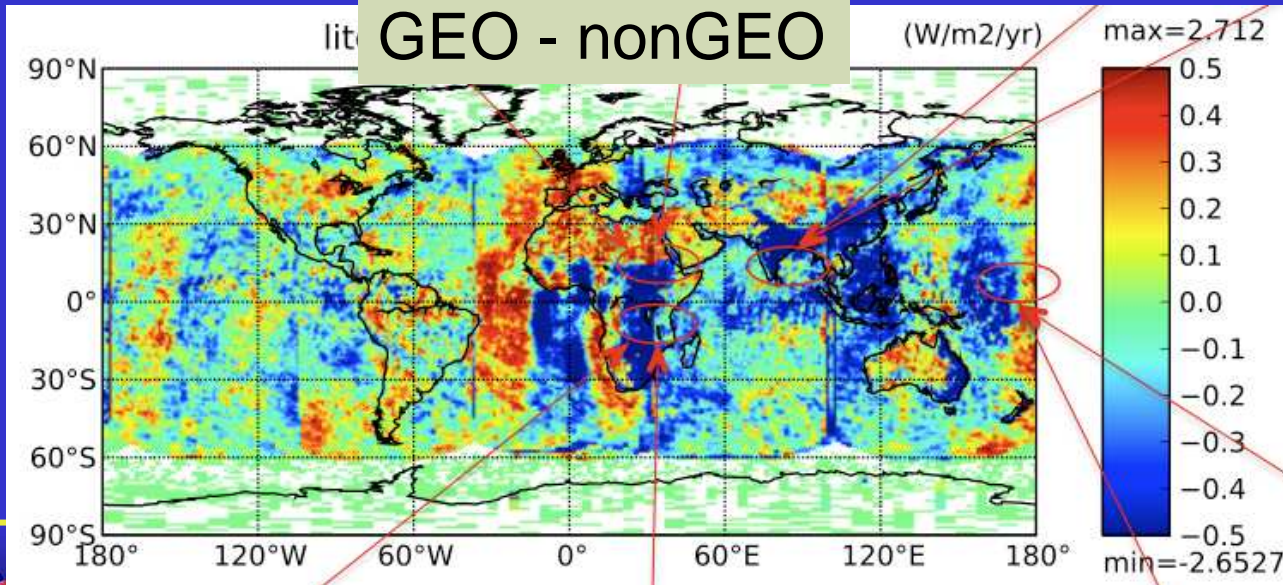
CERES/GEO



CERES-only



GEO - nonGEO

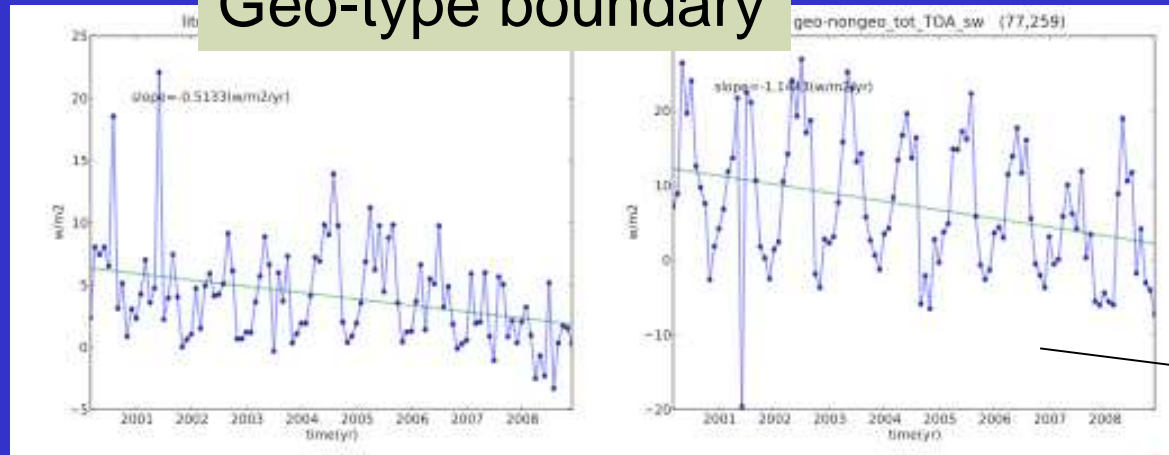


NASA Langley Research Center / Atmospheric Sciences

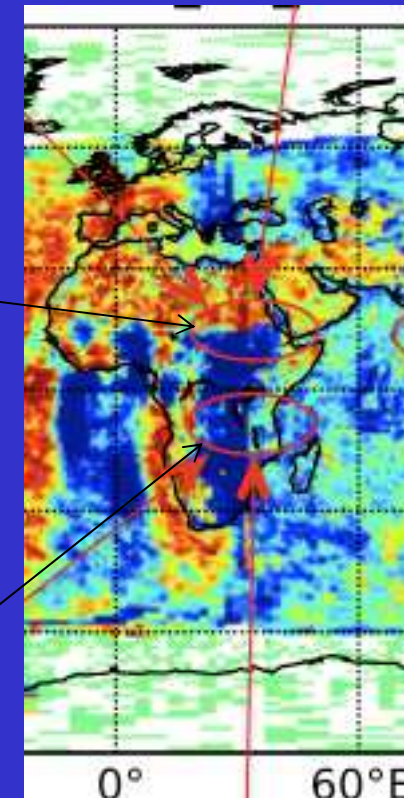
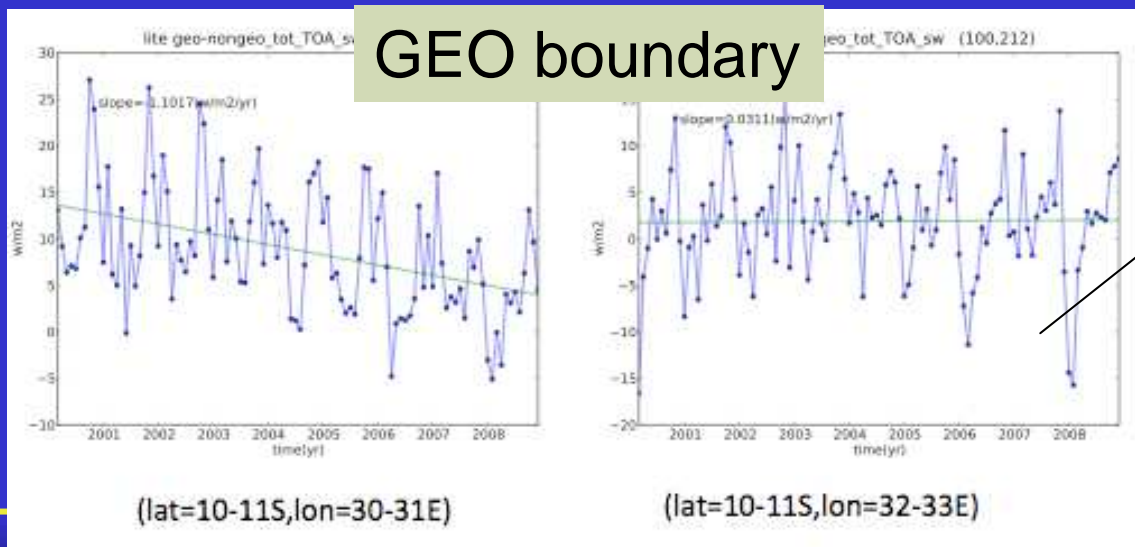


GEO-nonGEO 8-year SW trend anomalies

Geo-type boundary



GEO boundary

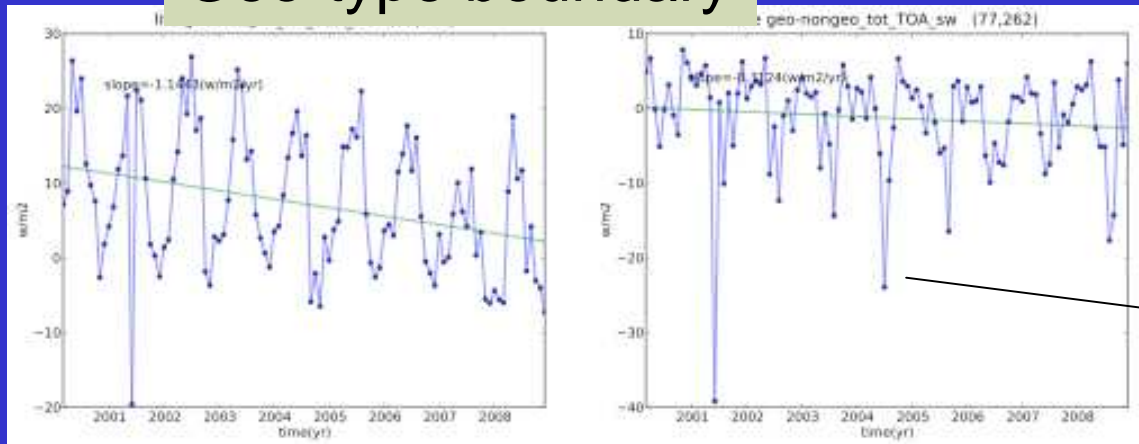


NASA Langley Research Center / Atmospheric Sciences

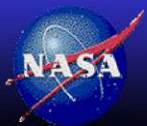
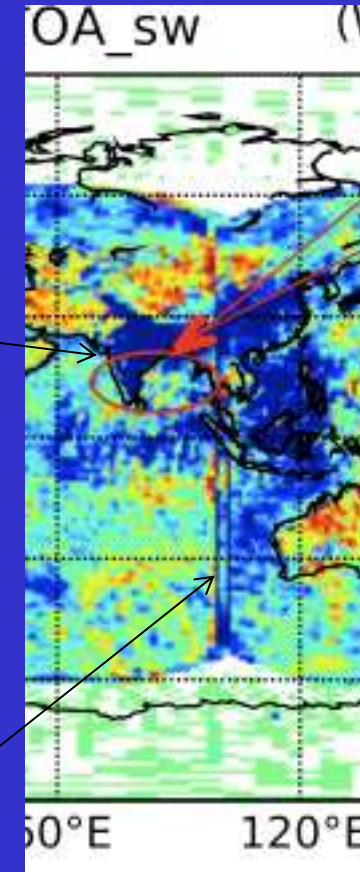
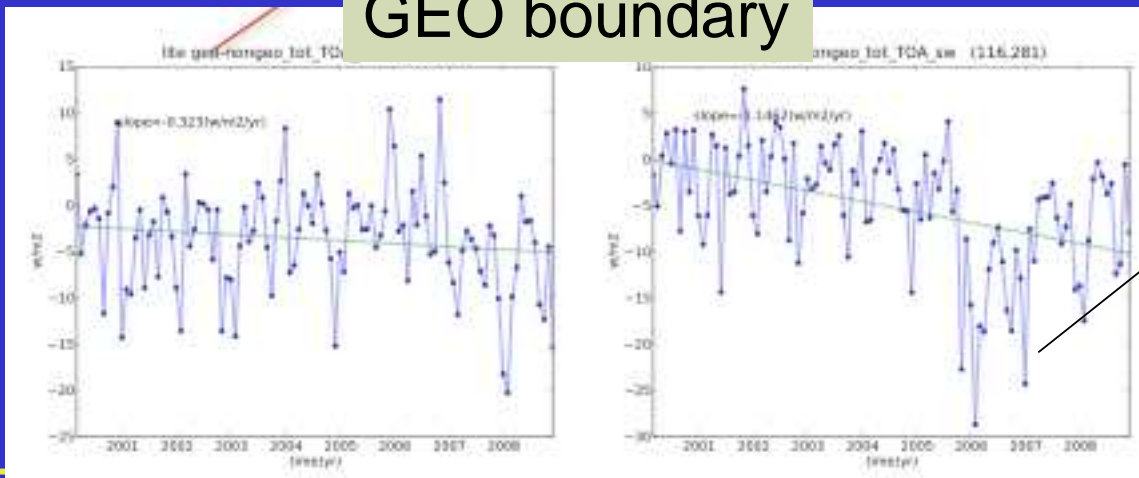


GEO-nonGEO 8-year SW trend anomalies

Geo-type boundary



GEO boundary



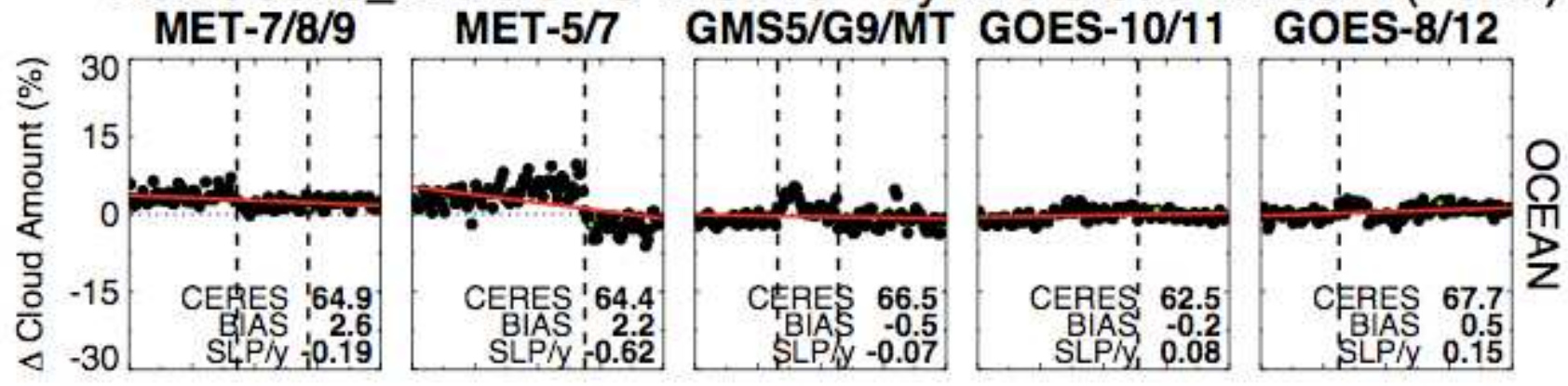
NASA Langley Research Center / Atmospheric Sciences



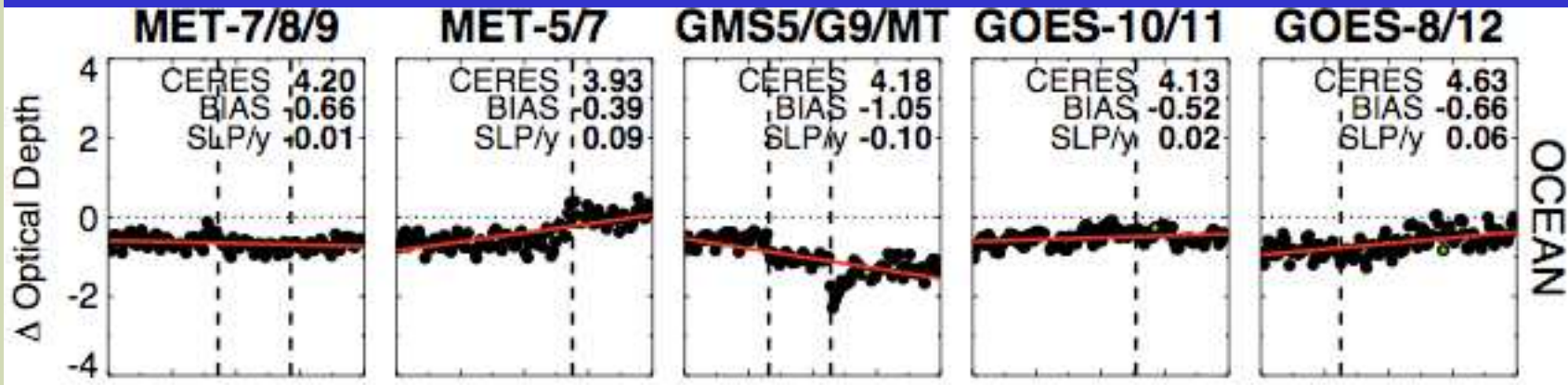
Coincident angularly matches between GEO/MODIS

Within 15 minutes, monthly means

Cloud amount



Optical depth

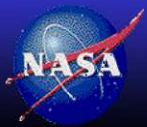


NASA Langley Research Center / Atmospheric Sciences



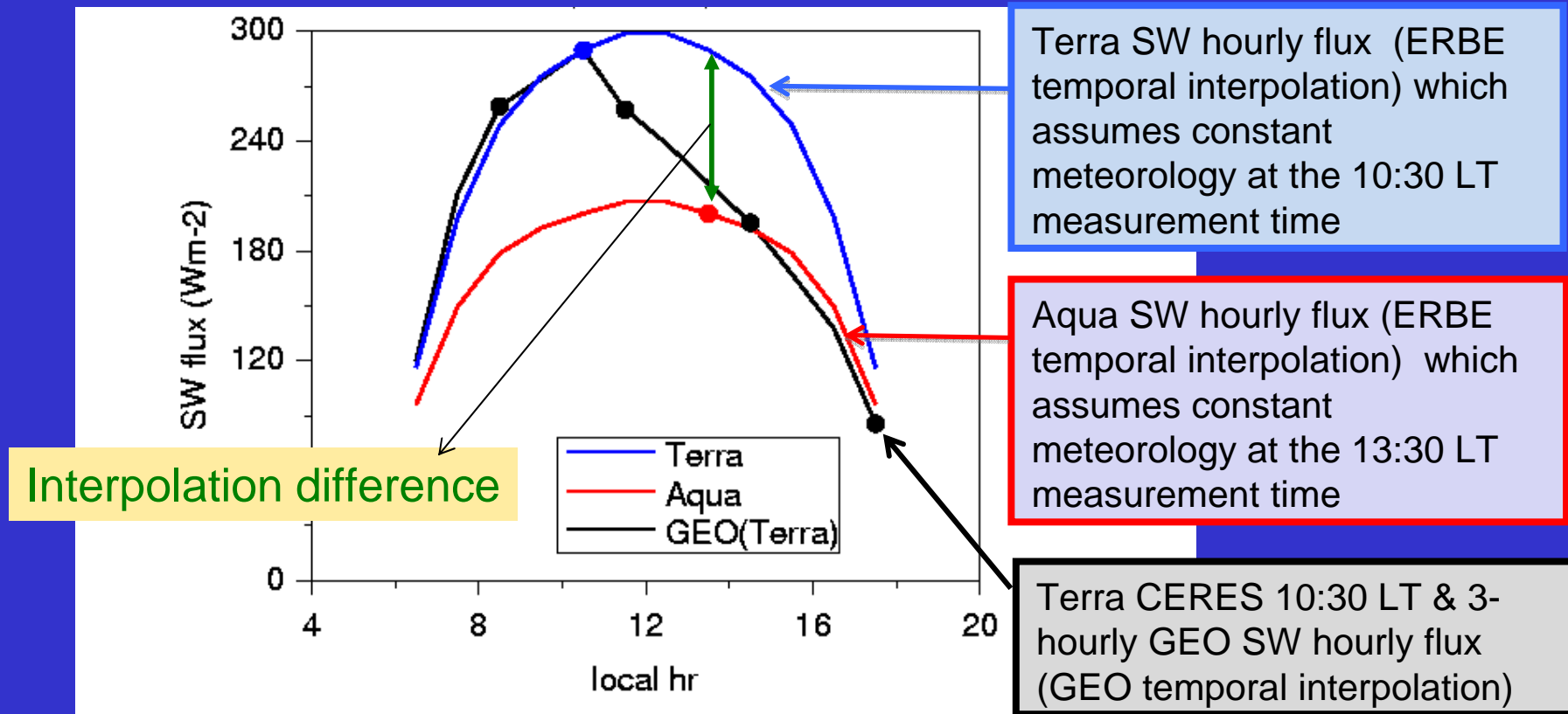
Outline

- Validate the diurnally interpolated CERES/GEO derived fluxes against ScaRaB coincident instantaneous fluxes
 - Examples of Terra interpolated vs Aqua or GERB
- Compare the monthly hourly regional fluxes against ScaRaB
 - Example from GERB
- Perform EOF analysis on the monthly hourly fluxes from both ScaRaB and CERES GEO fluxes
 - Are there GEO artifacts embedded in the diurnal cycle?



The merged CERES/GEO SW diurnal flux

- Peruvian maritime stratus region example, morning stratus clouds that burn off in the afternoon, expect greater SW flux in the morning than afternoon



- The Terra 10:30 and Aqua 13:30 cannot replicate diurnal coverage
- Use Geostationary derived fluxes to complete diurnal coverage



NASA Langley Research Center / Atmospheric Sciences

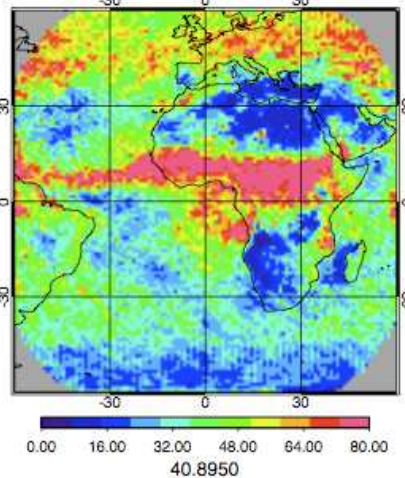


Terra diurnally interpolated vs GERB SW, July 2004

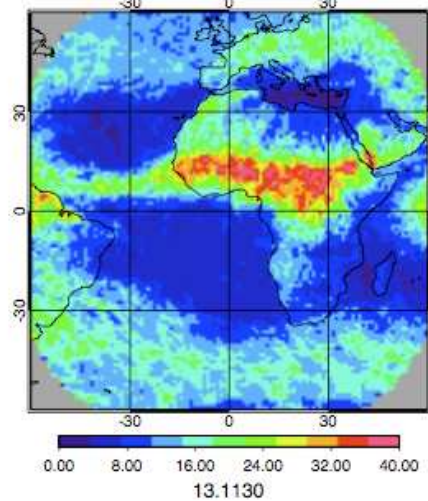
~24 Instantaneous comparisons per day

nonGEO

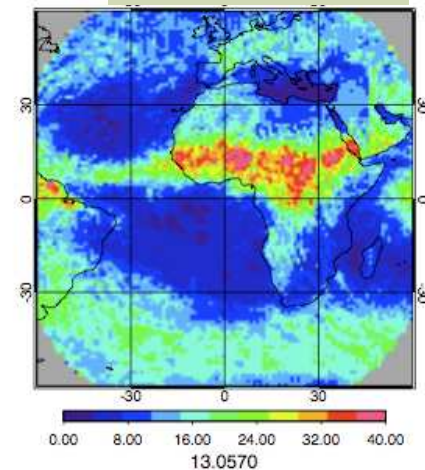
SW



LW day

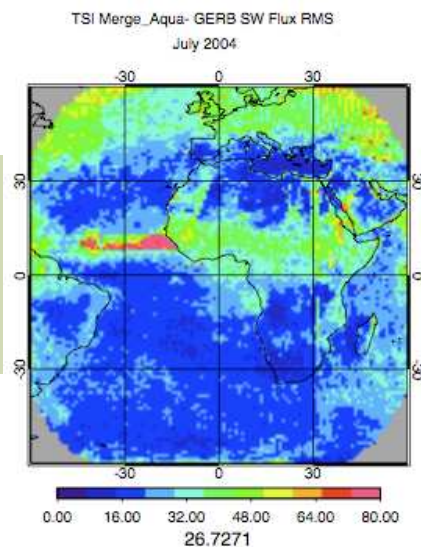


LW night

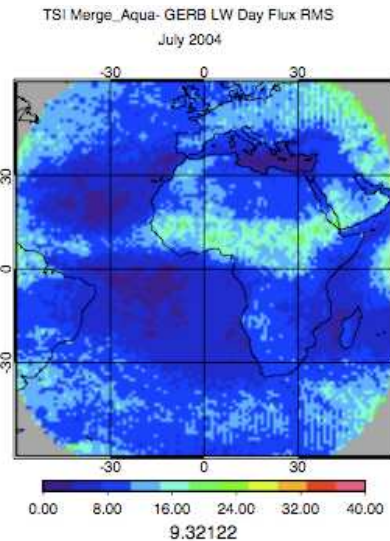


RMS

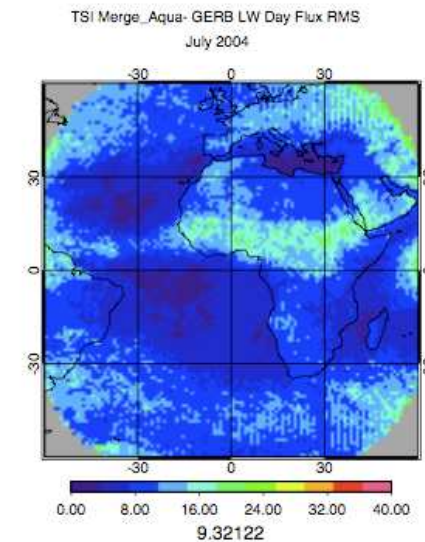
GEO



gley



mos

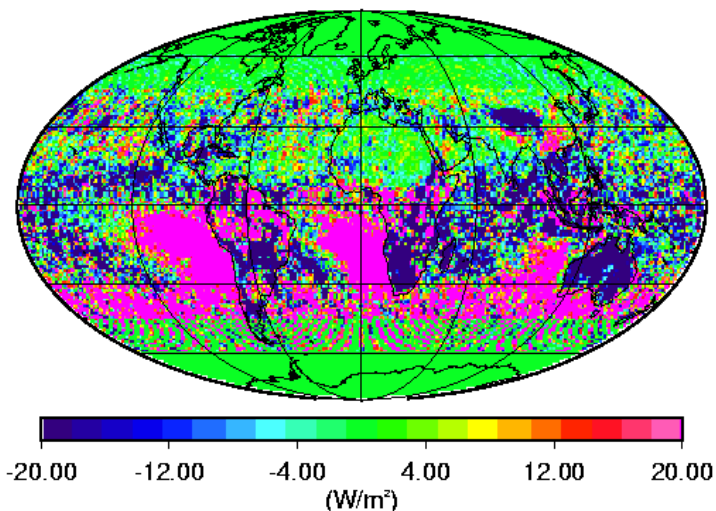


Terra Interpolated vs. Aqua Observed Total-sky TOA SW Flux

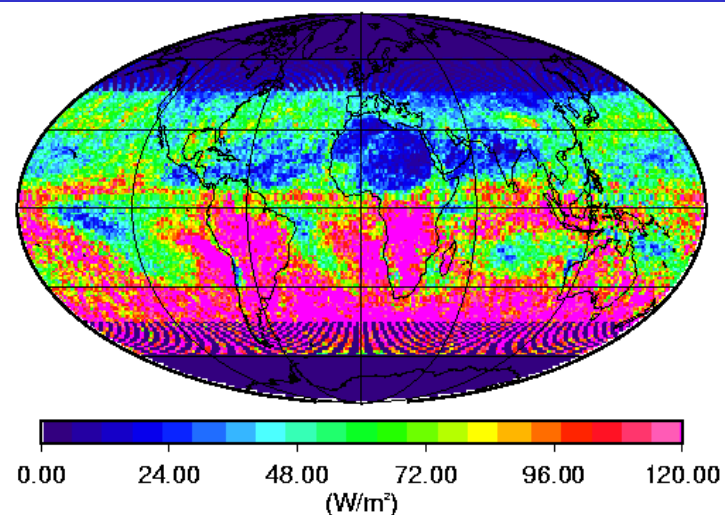
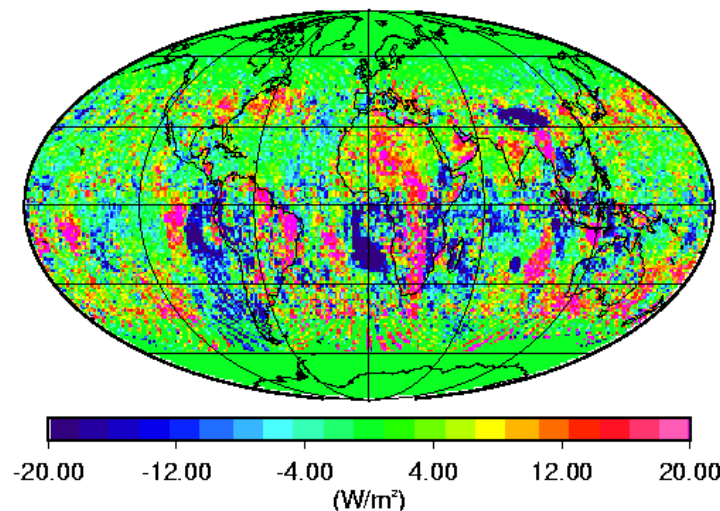
CERES-only

Instantaneous December 2002

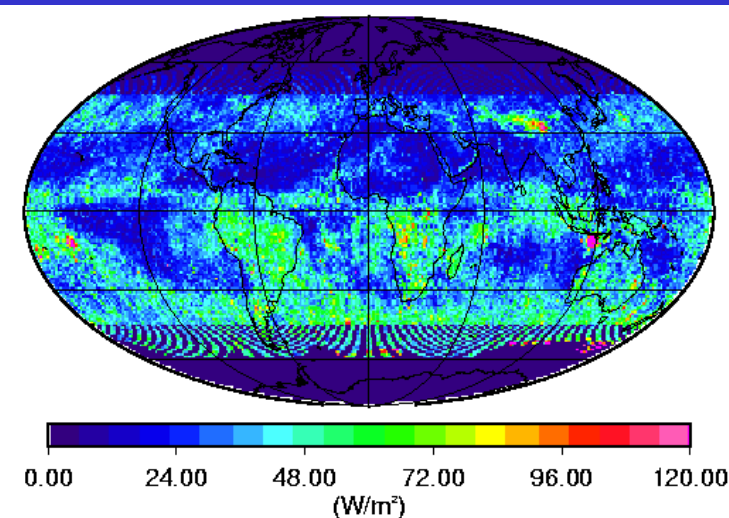
CERES/GEO



bias



RMS

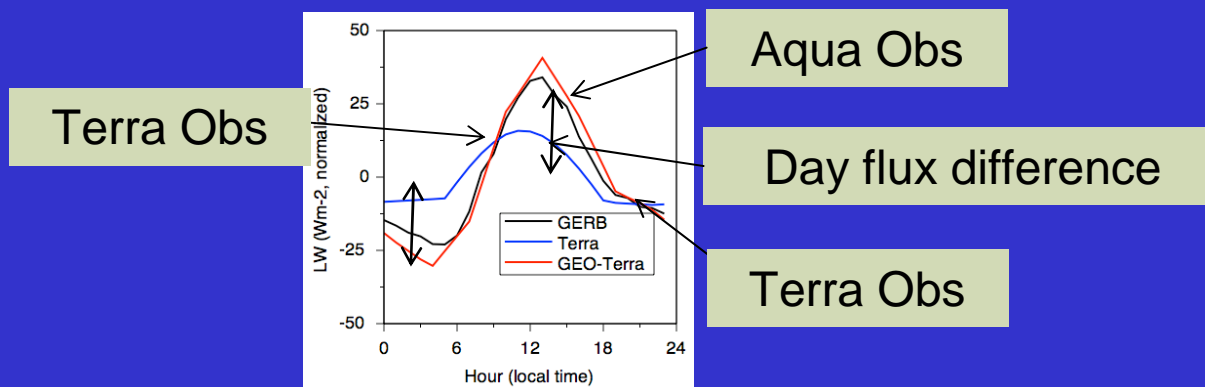


NASA Earth Science Data Center Atmospheric Sciences

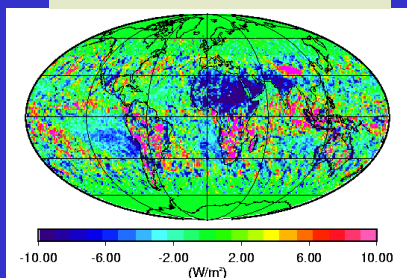
- For trends the bias is important



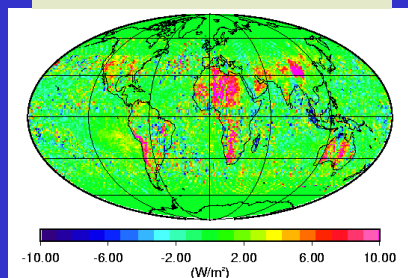
Terra Interpolated vs. Aqua Observed All-sky TOA LW Flux



CERES-only

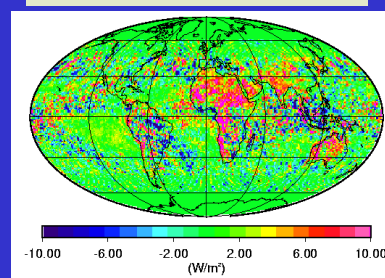


CERES/GEO

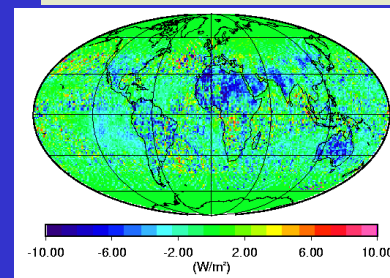


bias

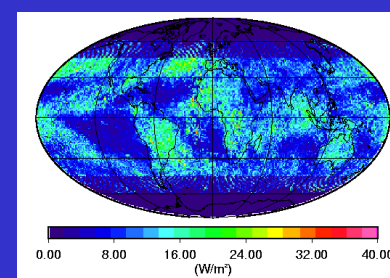
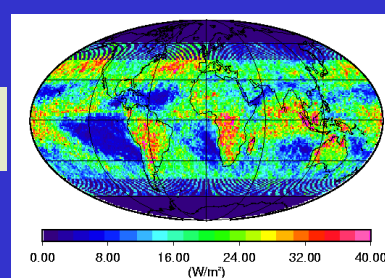
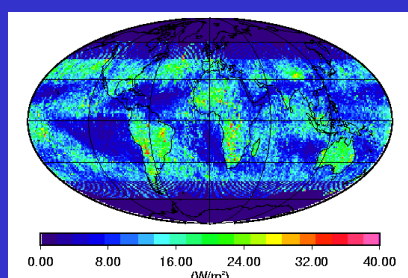
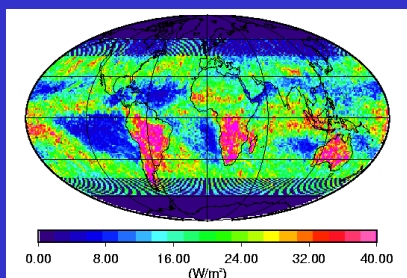
CERES-only



CERES/GEO



RMS



DAY

Instantaneous Dec 2002

Night

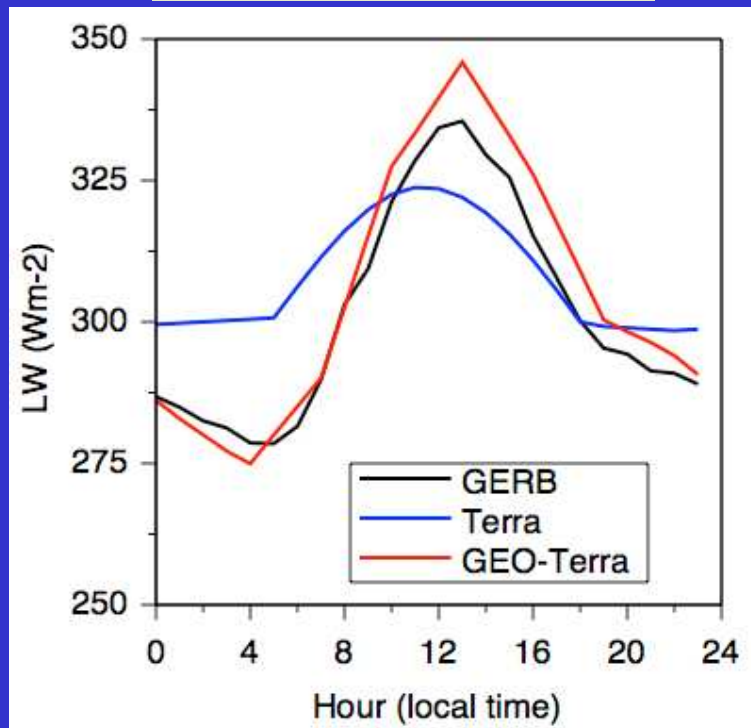


NASA Langley Research Center / Atmospheric Sciences

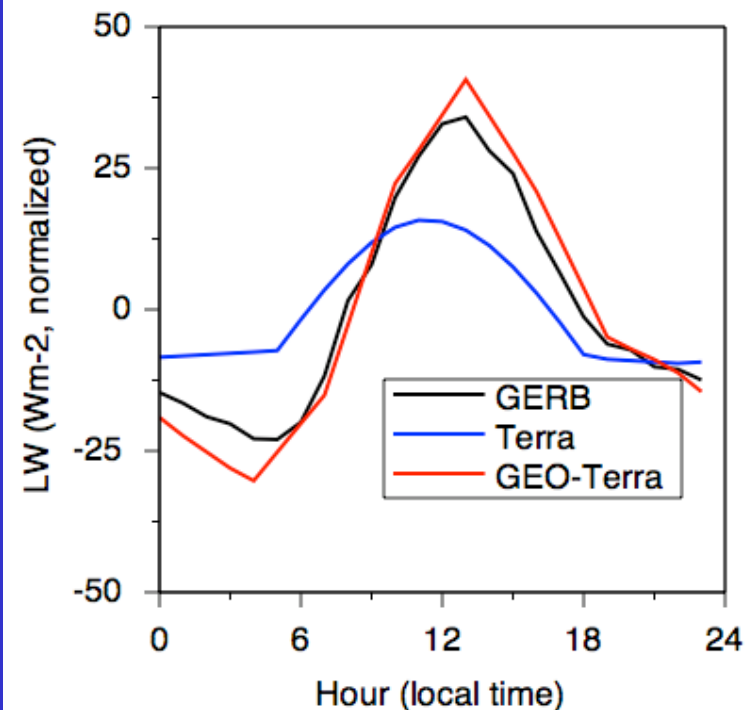


LW flux comparison for a Sahara desert region

Pre-normalized fluxes



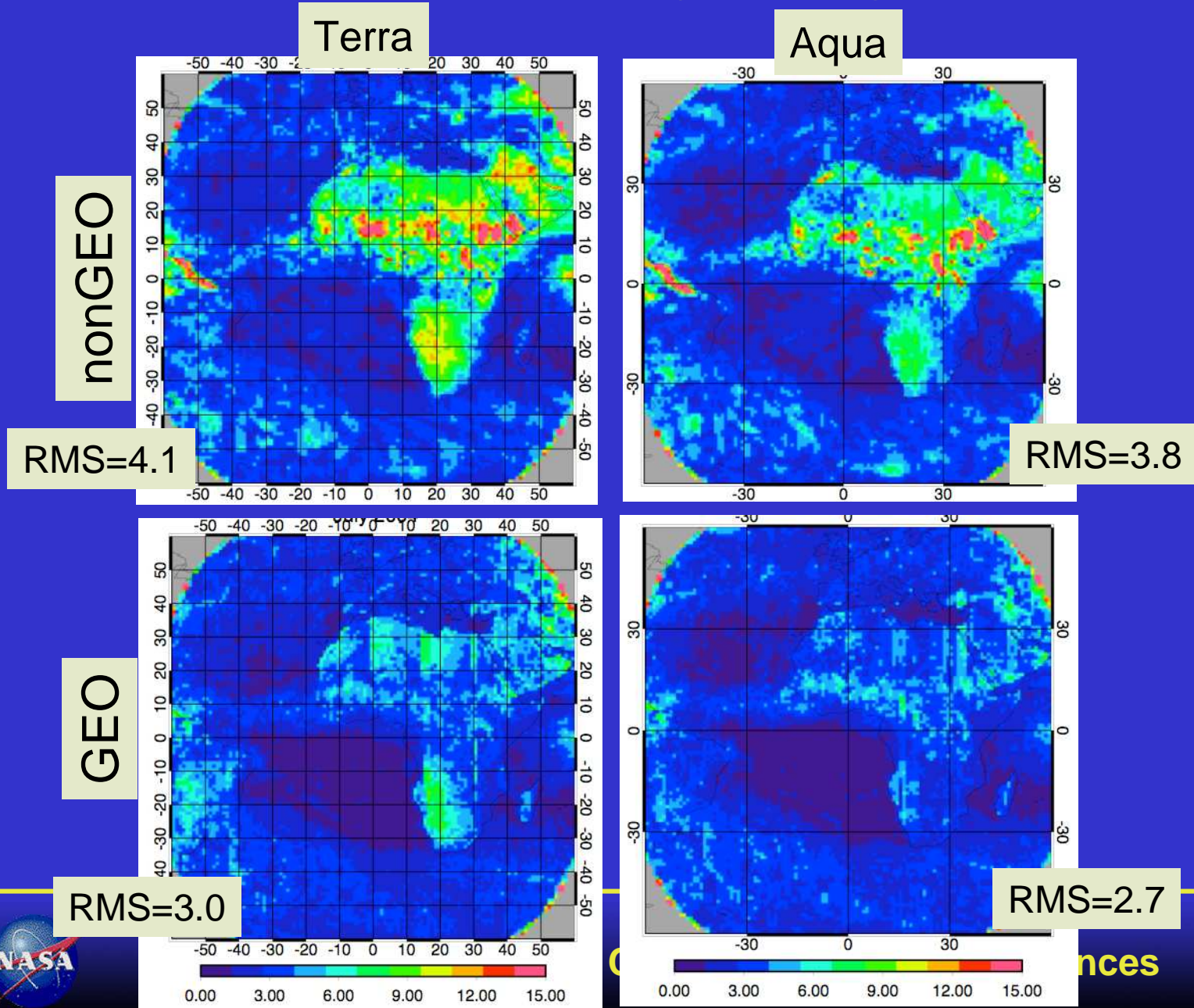
After monthly mean flux subtraction



- Note the Terra (nonGEO) diurnal model employs the half-sine fit
- The SRBAVG-GEO LW NB to BB is a global parameterization using relative humidity, and is the same for day or night.

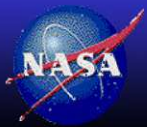


SRBAVG - GERB monthly hourly LW RMS error

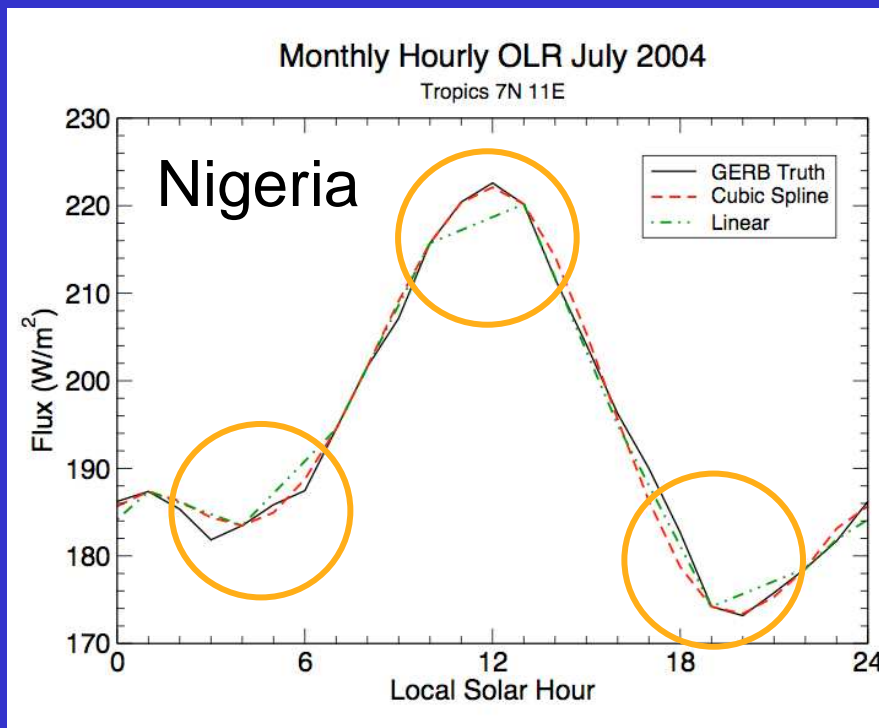
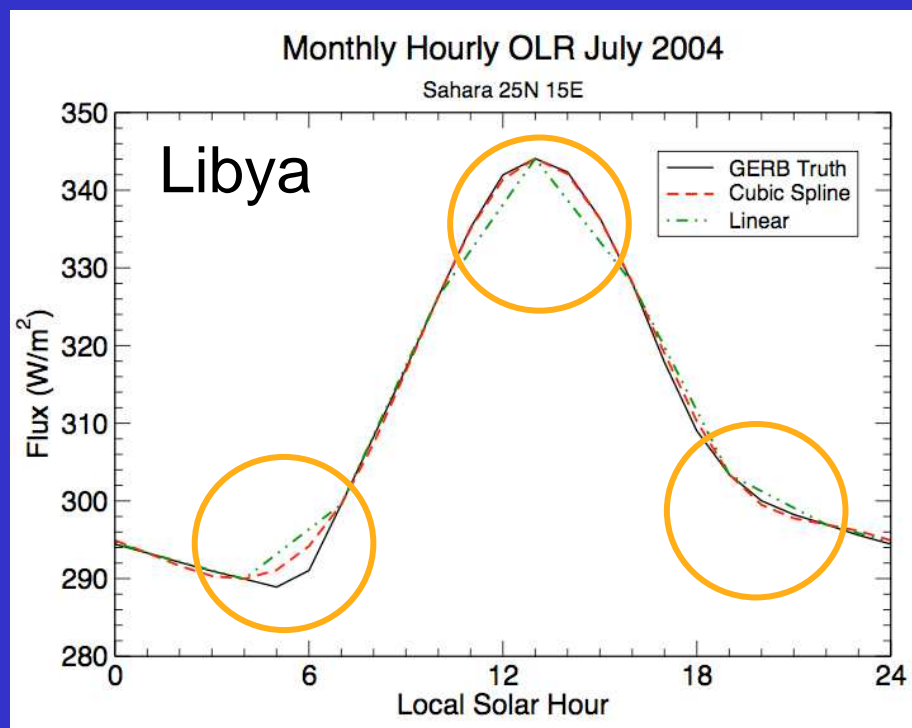


Test 1- and 3-hourly GEO with GERB LW fluxes

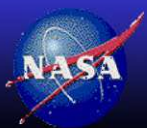
- Use hourly GERB LW fluxes as truth
 - Grid GERB footprint LW fluxes into 1° regions
 - G2_SEV1_L20_ARG_SOL_20040717_073557_ED01.hdf
G2_SEV1_L20_ARG_TH_20040717_073557_ED01.hdf
 - Apply LW empirical correction (4th order polynomial)
 - Remove the monthly mean GERB and SRBAVG-GEO LW flux difference regionally to remove calibration difference
 - GERB is the best dataset to monitor the regional TOA LW diurnal variation (shape)
- Sub sample GERB LW fluxes every 3-hours or 1-hourly to simulate GEO derived BB fluxes



Monthly Hourly LW comparison



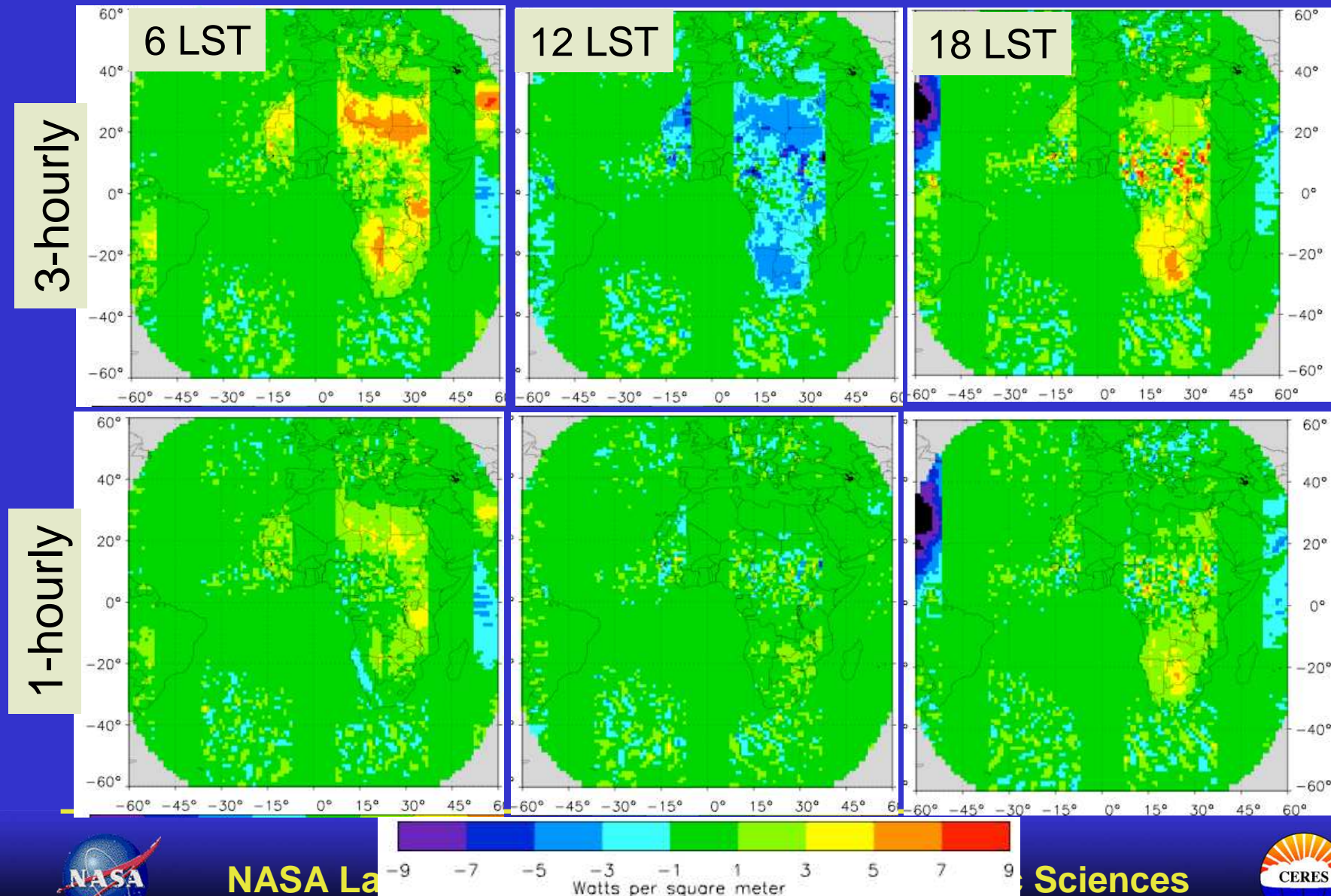
- 3-hourly vs 1-hourly is most noticed at maxima and minima



NASA Langley Research Center / Atmospheric Sciences



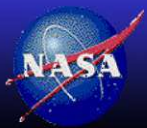
Comparison of LW flux biases



Summary of 1 and 3-hourly interpolation

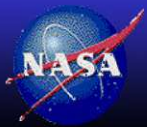
Hour	Bias (Wm-2)		RMS(Wm-2)	
	1-hourly	3-hourly	1-hourly	3-hourly
6	0.32	0.92	3.4	3.8
12	0.12	-0.74	3.4	3.9
18	0.00	0.39	3.8	4.2
1-24	-0.01	-0.02	2.8	3.1

- RMS is reduced by 10% for all hours and monthly
- Bias is closer to 0 for all hours
- The monthly means are the same for each method
 - 3-hourly interpolation deficiencies are compensated during the course of the day



Diurnal EOF analysis of GEO derived BB fluxes

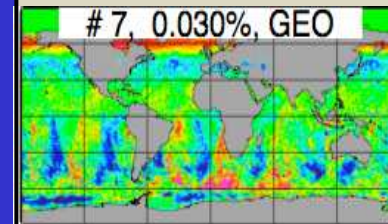
- EOF analysis can deconvolve the diurnal signal into diurnal and semi-diurnal cycles
 - Perform EOF analysis on Jan 2005 1° gridded monthly SW and LW hourly fluxes
- How much diurnal value is the SRBAVG GEO product adding?
 - The 25 GB/month of 3-hourly 5-satellite GEO dataset needs to be ingested, calibrated, processed for cloud retrievals and converted to BB and normalized to the CERES calibration
 - Is the GEO product providing more diurnal components than the nonGEO product?
 - Is the GEO product free of diurnal GEO artifacts?
 - Compare GEWEX SRB fluxes with GEO to determine if SRBAVG is an improvement over existing diurnal datasets
- Compare the SRBAVG-GEO product with GERB fluxes
 - GERB Edition1 data available
 - Are the GEO diurnal components similar to GERB?



EOF analysis, SW, Jan 2005, Ocean

GEO artifacts

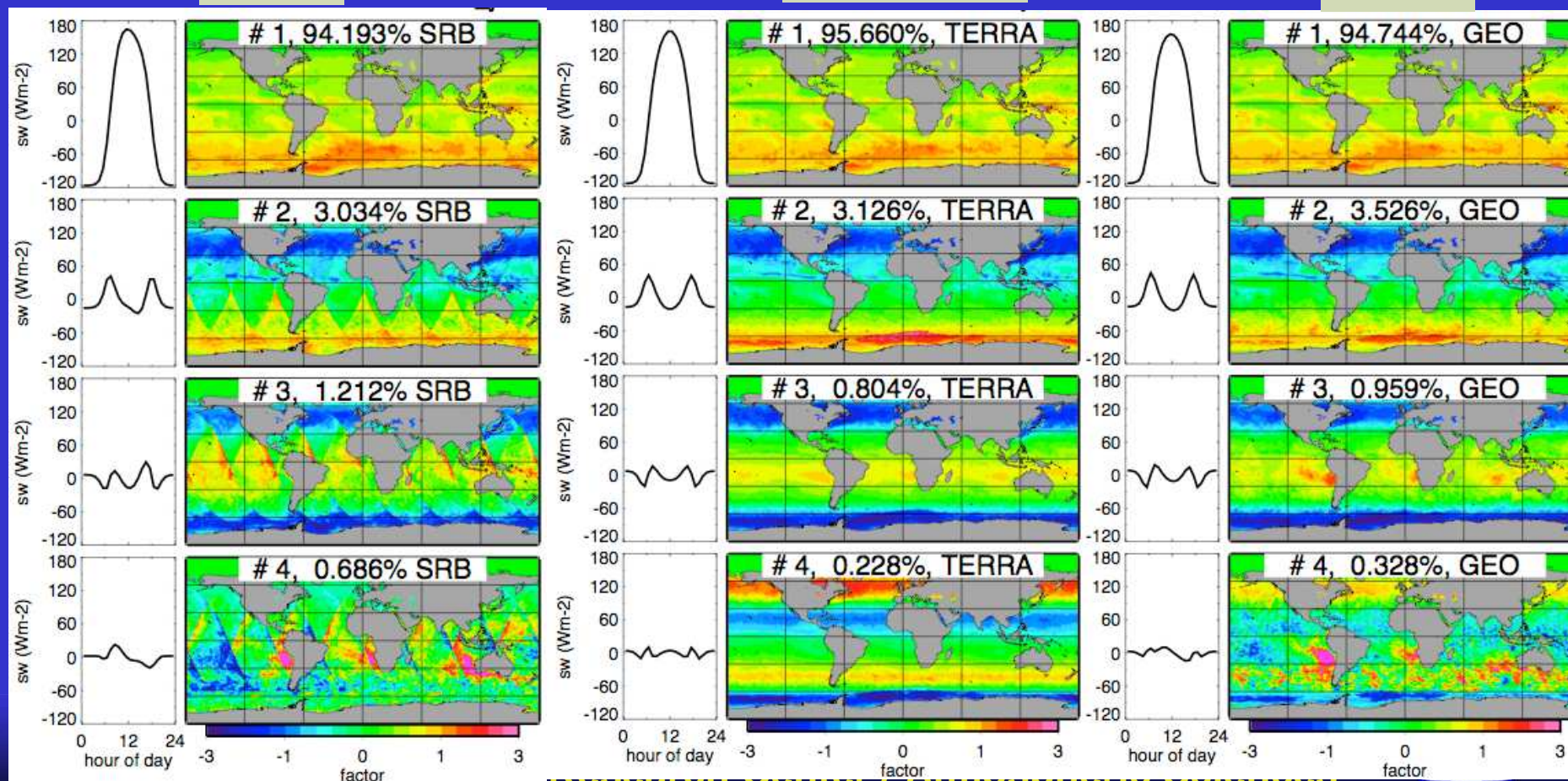
7, 0.030%, GEO



SRB

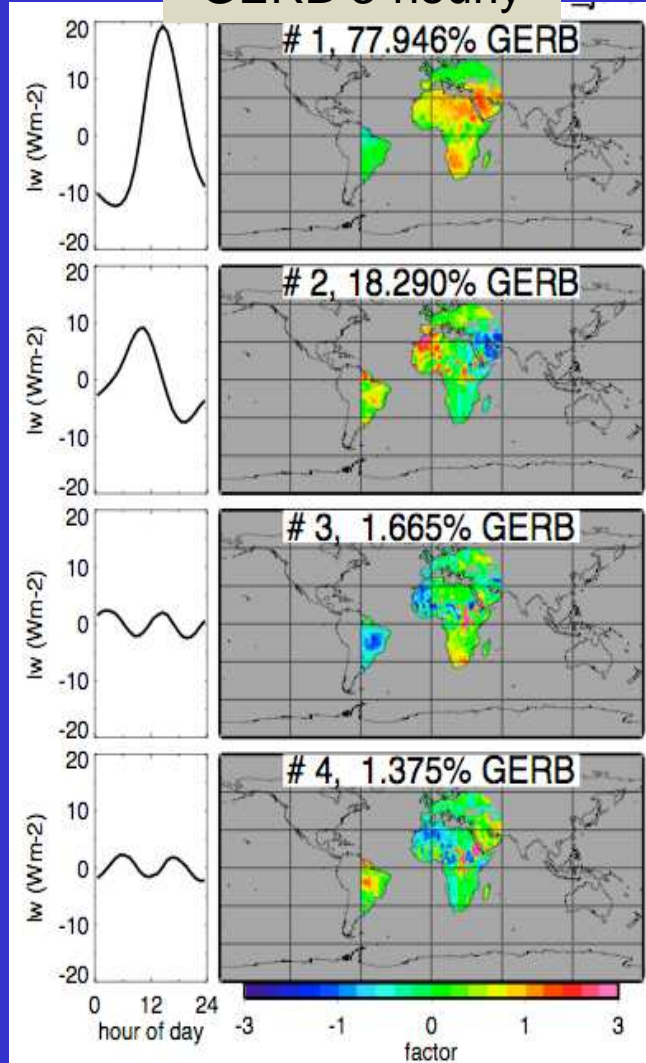
nonGEO

GEO

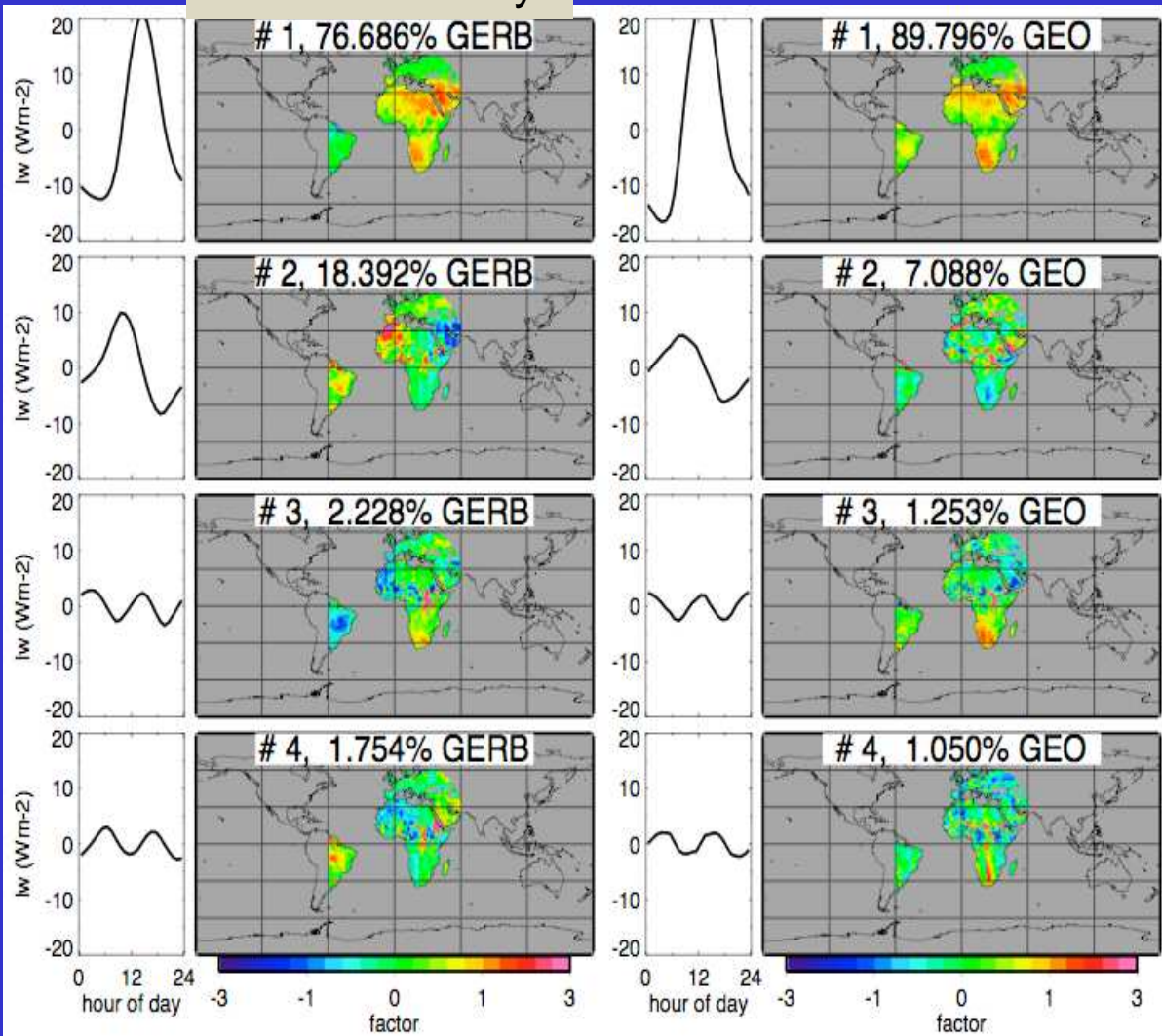


EOF analysis, LW, July 2004, Land, GERB

GERB 3-hourly



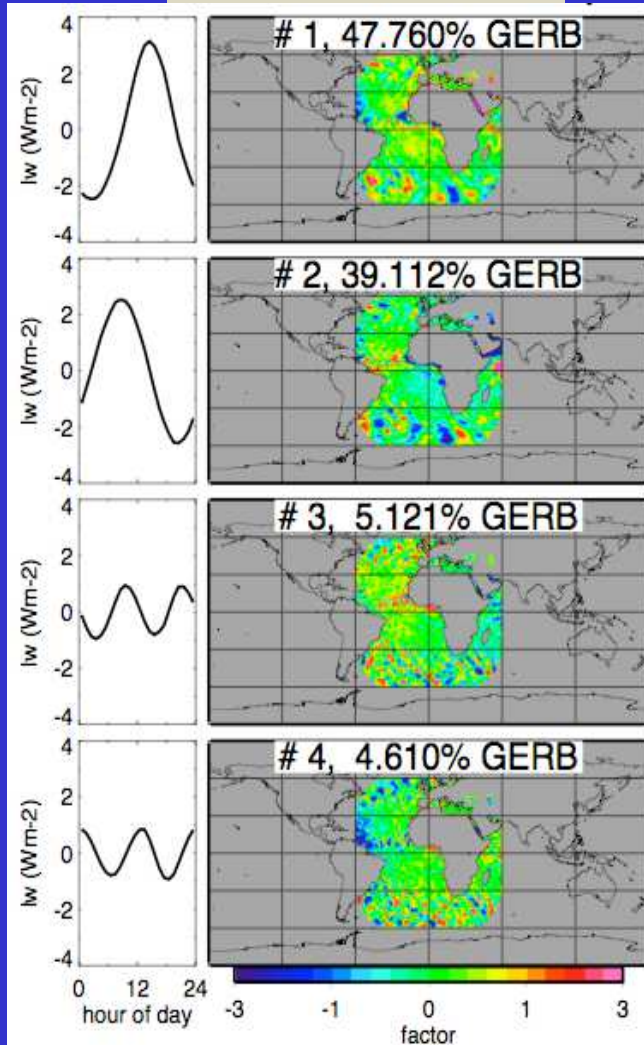
GERB 1-hourly



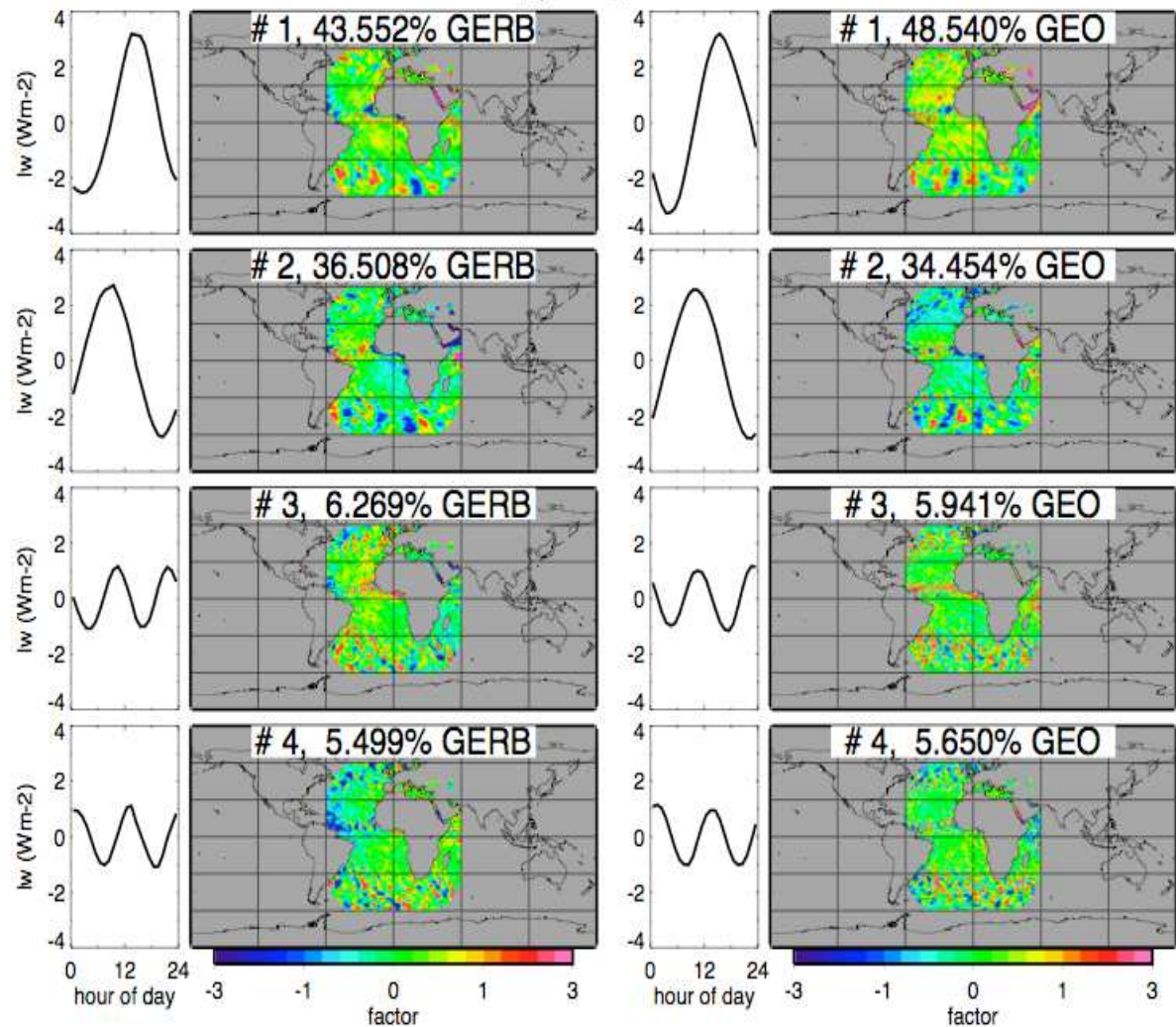
- There seems to be no added diurnal value going to 1-hourly LW
- Assume GERB dynamic range to be valid, transfer CERES calibration using coincident fluxes
- 1st EOF is very consistent between GERB and GEO

EOF analysis, LW, July 2004, Ocean, GERB

GERB 3-hourly



GERB 1-hourly



- There seems to be no added diurnal value going to 1-hourly LW
- GEO is getting the general shapes and explained variances, seems to be some shift in phase

Conclusions

- To get GEO to climate quality need to evaluate the bias as well as the RMS
 - Need to remove discontinuities in GEO satellite boundaries and GEO satellites
- Use CERES/GERB/ScaRaB synergy to improve GEO derived broadband fluxes
 - coincident instantaneous fluxes
 - Monthly hourly comparisons to get minima and maxima correct
 - EOF analysis to weed out GEO artifacts and compare components of the diurnal cycle

